PHILIPS

Operating manual

PM 3210 25 MHz Dual-trace oscilloscope

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IMPORTANT

In correspondence concerning this apparatus, please quote the type number and serial number as given on the type plate at the bottom of the apparatus.

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GENERAL INFORMATION

This section of the instruction manual deals with introductory material and basic information of interest to both operating and servicing personnel.
It includes specifications of physical and electrical data and a description of the operating principles of the instrument to block diagram level.
The three chapters found in this section are:

I. INTRODUCTION
II. TECHNICAL DATA
III. DESCRIPTION OF THE BLOCK DIAGRAM

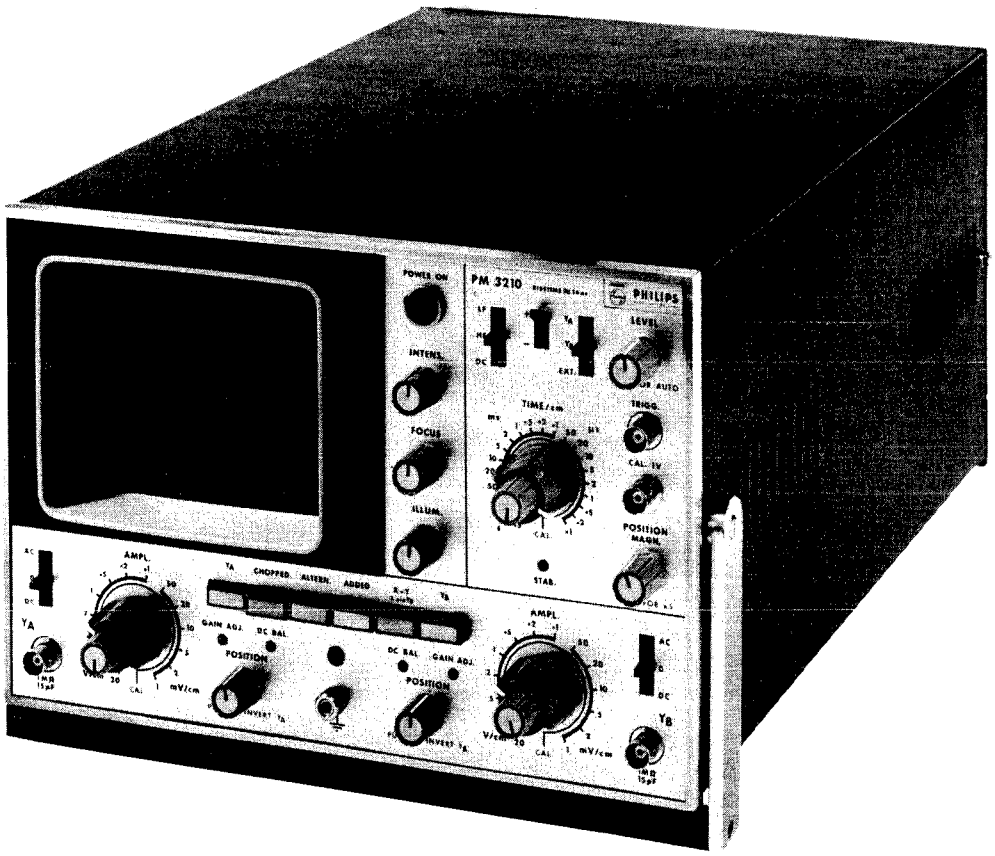


Fig. 1. General view

I. Introduction

The PM 3210 is a dual-trace oscilloscope with a bandwidth of 25 MHz at a maximum sensitivity of 1 mV/cm. The built-in electronic switch provides a great number of operating modes: CHANNEL A, CHANNEL B, CHOPPED, ALTERNATE, ADDED and XY. The mode XY with the same high sensitivity for the X and Y channels, together with a bandwidth of 5 MHz and a phase difference of less than 2^{o} between the channels, makes this instrument very useful for colour-television measurements.

The mechanical construction of the instrument shows a building-brick system that ensures an extremely quick and efficient service.

II. Technical data

Y AXIS

Two identical amplifier channels A and B. The polarity of both channels can be inverted.

Bandwidth	DC: 0 Hz ... 25 MHz (–3 dB) AC: 2 Hz ... 25 MHz (–3 dB)
Rise time	14 ns
Deflection coefficients	14 calibrated ranges from 1 mV/cm to 20 V/cm in 1–2–5 sequence. A vernier provides uncalibrated, continuous control between the ranges.
Measuring accuracy	± 3 %
Overshoot (in position 50 mV/cm of the input attenuator)	less than 2 % for pulses with a rise time ⩾ 3 ns and a trace height of 6 cm
Input impedance	1 MΩ//15 pF
Input RC time with a.c. coupling	100 ms
Maximum input voltage	500 V (d.c. + a.c. peak)
Maximum deflection	for sine-wave signals with frequencies up to 10 MHz, the vertical deflection is undistorted for a total amplitude equivalent to 24 cm. With the aid of the shift controls, the peaks of such a signal can be displayed.
Signal delay	delay time for each channel: 150 ns visible delay : ⩾ 20 ns
D.C. drift at maximum sensitivity	1 cm/hour at a constant ambient temperature of 25 °C (77 °F)
Display modes	– channel A only – channels A and B chopped, the display time for each channel being 1 µs – channels A and B alternate – channels A and B algebraically added. Using the polarity inversion of both channels, the following displays are possible: A+B, A–B, B–A, –B–A. Common mode rejection factor: 100 (from 0 Hz to 1 MHz, after adjustment of GAIN ADJ.) Maximum signal per channel: 24x attenuator setting – X-Y operation. Channel B forms the horizontal channel Bandwidth: 0 Hz ... 5 MHz with a phase difference of 2° at maximum between the channels. Maximum deflection in X direction: 6 cm for sine-wave signals with frequencies up to 5 MHz. – channel B only
Y signal output	approximately 200 mV/cm. The output is protected against short-circuits

CALIBRATION

Calibration voltage	1 V ± 1 %, square wave
Frequency	approximately 2.5 kHz

TIME AXIS

Time coefficients	21 calibrated ranges from 100 ns/cm to 0.5 s/cm in 1–2–5 sequence. A vernier provides uncalibrated, continuous control between the ranges.
Measuring accuracy	± 3 %
Magnifier	5x (50 cm). Any 10 cm of the expanded sweep can be displayed. The maximum effective time coefficient is 20 ns/cm. The measuring accuracy with expanded sweep is ± 5 % (measured between 10 % and 90 % of the time-base sweep).
Time-base output	5 V, sawtooth voltage. The output is protected against short-circuits. Output resistance: 2 kΩ Load : With an $R_{load} \geqslant 5$ kΩ and a $C_{load} \leqslant 100$ pF, the deviation of the time coefficient is less than 10 %

TRIGGERING

Trigger system	the time-base generator operates in the triggered mode when an input signal is applied. An auto-circuit can be switched in to provide a time-base line in the absence of an input signal.
Trigger source	channel A, channel B or external source
Trigger slope	+ or –
Trigger coupling	in position LEVEL DC : 0 Hz ... 25 MHz HF : 10 kHz ... 25 MHz LF : 10 Hz ... 10 kHz in position AUTO DC : 10 Hz ... 25 MHz HF : 10 kHz ... 25 MHz LF : 10 Hz ... 10 kHz

Trigger sensitivity and bandwidth

	0 Hz–10 Hz		10 Hz–10 kHz		10 kHz-5 MHz		5 MHz–15 MHz		15 MHz–25 MHz	
	INT.	EXT.	INT.	EXT.	INT.	EXT.	INT.	EXT.	INT.	EXT.
LF	–	–	0.5 cm	0.5 V	–	–	–	–	–	–
HF	–	–	–	–	0.5 cm	0.5 V	1 cm	0.5 V	3 cm	1 V
DC	0.5 cm	0.5 V	0.5 cm	0.5 V	0.5 cm	0.5 V	1 cm	0.5 V	3 cm	1 V

Input impedance of the external trigger input	1 MΩ//40 pF
Maximum input voltage	500 V (d.c. + a.c. peak)
Level range (measured with 10 kHz signal and continuous attenuator in position CAL.)	– internal level : more than 16 cm – internal auto : approximately 3 cm – external level : more than 10 Vp-p – external auto : approximately 1.5 Vp-p

C.R.T.

Type	D14–120GH with medium-short persistence phosphor *)
Useful screen area	8 cm x 10 cm
Graticule	external, with cm-divisions
Total acceleration voltage	10 kV

*) Instruments fitted with a GM-tube with long persistence phosphor are available under type number PM 3210G.

Z-MODULATION

Internal	unblanking by time-base generator. In position CHOPPED the beam is suppressed during switching.
External	D.C. coupled
Required voltage	5 Vp-p (50 Vp-p at maximum)
Short-term overload	500 Vp-p at maximum
Input impedance	approximately 10 kΩ // 20 pF
Bandwidth	0 Hz ... 10 MHz

SUPPLY PART

Mains voltages	110 V, 125 V, 145 V, 200 V, 220 V, 245 V
Mains frequency	46–400 Hz
Power consumption	95 W
Influence of ± 10 % mains voltage fluctuations	nil

ENVIRONMENTAL CONDITIONS

The instrument can be used either in horizontal or vertical position.

Temperature range	Operating within specification	: 0 ... +45 °C
	Operating	: −10 ... +55 °C
	Storage	: −40 ... +70 °C

The instrument meets the VDE 0875 Störgrad K requirement.

OVERALL DIMENSIONS AND WEIGHT

Height	: 20 cm
Width	: 30 cm
Depth	: 47.5 cm
Weight	: 13 kg

Properties expressed in numerical values with tolerances stated are guaranteed by the factory. Numerical values without tolerances stated represent the properties of an average instrument and merely serve as a guide. All data apply in case of nominal mains voltage unless otherwise stated.

OPTIONAL ACCESSORIES

(The standard accessories supplied with the instrument have been listed in Chapter IV. INSTALLATION.)

– Passive probe with 1.15 m cable	PM 9326
– Passive probe with 2 m cable	PM 9327
– Passive h.f. probe	PM 9350
– Polaroid oscilloscope camera	PM 9380
– Adapter for camera	PM 9378
– Supplementary lens	PM 9373
– Rack-mount kit	PM 9361
– Trolley	PM 9395

III. Description of the block diagram

Y-AXIS

An input signal applied to socket Y_A or Y_B is fed to unit 1 or unit 2. These units are identical and contain the following circuits: an input step-attenuator, a protection circuit, a pre-amplifier and a drift-compensation circuit, the continuous attenuator and the gain pre-set control.
The protection circuit prevents damage to the input field-effecttransistors by too high an input voltage.
The drift-reduction circuit reduces the drift inherent in the high sensitivity of the amplifier.
Via the delay line the signal is fed to the intermediate amplifier on printed-wiring card 4.

Printed-wiring card 4 comprises four main parts:
1. an intermediate amplifier receiving the signal from the pre-amplifier of channel A.
2. an identical amplifier for channel B. These two amplifiers are equipped with shift and polarity controls.
3. the diode switch, which is controlled by the switch-driver circuit.
4. the Y output amplifier that feeds the signal to the vertical-deflection plates.

TRIGGERING

The triggering signal from the pre-amplifier of channel A or B, or from an external source can start the time-base generator (unit 3).

TIME BASE

The time-base unit is provided with an optional auto-circuit that makes the time-base generator free-running when there is no triggering signal.
The time-base unit supplies the following output voltages:
1. a sawtooth voltage. Via the printed-wiring board this sawtooth voltage is fed to the X-amplifier unit 7 and to a socket on the rear panel of the instrument.
2. a gate pulse which is fed to combination unit 8 via the printed-wiring board. This gate pulse controls the unblanking of the c.r.t. during the sweep.
3. an alternate pulse. This pulse controls the switch driver unit 5, which in its turn controls the diode switches.

X-AXIS

The X amplifier consists of three parts:
1. the time-base amplifier. This amplifier feeds the sawtooth voltage from time-base unit 3 symmetrical and amplified to:
2. the diode switch which, as dictated by switch driver unit 5, connects the time-base signal or the signal from channel B to:
3. the X-output amplifier which feeds the signal to the X-deflection plates of the c.r.t.

DIODE SWITCH

The diode switch is part of the horizontal as well as of the vertical path and can, together with the switch driver, accomplish the following situations.
1. Channel A is connected to the Y output amplifier and the sawtooth voltage from unit 3 is fed to the X-amplifier.
2. Channels A and B are in turns connected to the Y output amplifier for approx. 1000 ns (position CHOPPED). The sawtooth voltage from unit 3 is connected to the X-amplifier.
3. Channels A and B are alternately connected to the Y output amplifier at every fly-back of the time-base sweep (position ALTERNATE).
   The sawtooth voltage from unit 3 is fed to the X-amplifier.
4. Channel B is connected to the X output amplifier and channel A to the Y output amplifier (position X-Y).
   In this position the bandwidth is limited in the Y output amplifier. The bandwidths of the two channels (A vertical and B horizontal) are now the same (5 MHz at a phase difference $\leqslant 2^{o}$).
5. Channel B is connected to the Y output amplifier, the sawtooth voltage from unit 3 is fed to the X-amplifier.

SWITCH DRIVER

The switch driver unit 5 consists of the following parts.
1. a push-button switch, which enables the switching in of the positions described above.
2. a blocking oscillator which oscillates at a frequency of about 2 MHz, in position CHOPPED.
   In position ALTERNATE the blocking oscillator is triggered by the alternate pulse. Triggering is such that the oscillator supplies a pulse at every fly-back of the

DIRECTIONS FOR USE

This section of the instruction manual is essentially of interest to operating personnel. It deals with the information necessary for installing and operating the equipment correctly, outlines its capabilities, reviews basic measuring principles and suggests techniques for obtaining the best results in various applications.

The three chapters found in this section are:

IV. INSTALLATION
V. OPERATING INSTRUCTIONS
VI. APPLICATIONS
VII. BRIEF CHECKING PROCEDURE

ADDED	: vertical deflection is achieved by the sum signal of channels A and B.
XY	: horizontal deflection is achieved by a signal applied to the B channel and vertical deflection by a signal connected to the A channel.
B	: vertical deflection is achieved by the signal connected to the channel B input.

Channel A/B

AC–0–DC (SK9/SK11)	signal coupling, three position switch: AC : via a coupling capacitor. 0 : interruption of connection between input socket and input circuit, the latter being earthed. DC : direct coupling.
AMPL. (SK12/SK13)	control of the vertical deflection coefficients, 14-way switch.
CAL–AMPL. (R8/R13)	continuously variable control of the vertical deflection coefficients. In the CAL. position the deflection coefficient is calibrated.
GAIN ADJ. (R9/R12) (screw-driver operated)	continuously variable control of the gain of the vertical channels.
DC BAL (R10/R11) (screw-driver operated)	continuously variable control of the direct voltage balance of the vertical amplifiers.
1 MΩ/15 pF (BU3/BU5)	input BNC socket for the vertical deflection signals.
SHIFT (R14/R15)	continuously variable control giving vertical positioning of the display.
PULL FOR –A/–B (SK14/SK15)	push-button control for inversion of the signal polarity.

Cathode Ray Tube Controls

INTENS. (R2)	variable control of trace brightness.
FOCUS (R3)	variable control of electron beam focusing.
ILLUM. (R5)	variable control of graticule illumination.

Miscellaneous Controls

POWER ON (SK1)	toggle switch for the mains supply to the oscilloscope.
CAL. 1 V (BU2)	output BNC socket for 1 V square-wave voltage for calibration purposes.
⏚ (BU4)	earth socket.

Sockets on the rear panel (Fig. 4)

TB OUT (BU6)	sawtooth output BNC socket.
Y OUT (BU7)	Y-amplifier output BNC socket.
Z-MOD (BU8)	input BNC socket for intensity-modulation voltages.

B. PRELIMINARY SETTINGS

We recommend to allow a warming-up period of approximately 5 minutes before you start your measurements.

- Check that the mains voltage adapter indicates the local mains voltage. If necessary remove the cover and set the adapter to the relevant value and see that the right fuse has been inserted.
- Switch on the instrument.
- Set ILLUM R5 for a suitable graticule illumination.
- Set INTENS R2 and FOCUS R3 to their mid-positions.
- Pull LEVEL SK5 to position AUTO.
- Display two traces by means of SHIFT controls.

The oscilloscope is then ready for use.
For minor adjustments, such as d.c. balance or gain, refer to chapter VII. BRIEF CHECKING PROCEDURE.

C. THE INPUTS A AND B AND THEIR POSSIBILITIES

The PM 3210 has been provided with two identical inputs and pre-amplifiers which can be used in various combinations, either for YT measurements in combination with the time-base generator, or for XY measurements up to frequencies of 5 MHz.

1. YT Measurements

a. Displaying one signal

To display one phenomenon either of the two vertical inputs can be selected by operating push-button A or B of switch SK10.
The polarity of the display can be inverted by pulling the SHIFT knob of the relevant channel.
One channel display ensures the highest intensity, and writing-speed for single transients and other signals with low duty-cycles.

b. Displaying two signals

When push-button CHOPPED or ALTERN. of switch SK10 is operated, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually.
When push-button ALTERN. of SK10 is depressed, the display is switched over from one channel to the other at the fly-back of the time-base signal.
Although the ALTERN. mode can be used at all sweep times of the time-base generator, the CHOPPED mode will give a better display quality for long sweep-times, because during these long sweep-times the alternate display of the two connected signals is clearly visible to the eye.
In the CHOPPED mode, the display is switched over from one channel to the other with a fixed frequency. With short sweep-times the display quality will be better in the ALTERN. mode.

If push-button ADDED of switch SK10 is operated, the voltages of both vertical channels are added. Depending on the positions of the polarity switches, either the sum or the difference of the input signals is displayed.
The ADDED mode also enables differential measurements. With these measurements advantage is taken from the common mode rejection in the ADDED mode. When the polarity switches are set to opposite positions, the common mode parts of the signals on sockets Y_A and Y_B will undergo a very slight amplification only, with respect to the differential mode parts.

2. XY Measurements

If push-button XY of switch SK10 is operated, the time-base generator is switched off. The signal of the B channel is horizontally displayed. The B channel knobs then control the horizontal deflection.
In this mode, calibrated XY measurements can be effected at frequencies up to 5 MHz. For this frequency range the phase difference between both channels is less than 2^{o}.

3. Influence of the AC–0–DC switch

The signals to be studied are fed to the input sockets Y_A, Y_B, or both. Depending on the composition of this signal, switch AC–0–DC should be set to position AC or DC. In position DC, the input is directly coupled to the Y amplifier. Because the Y amplifier is a d.c. coupled amplifier the complete bandwidth of the instrument is available. This means that input voltages are fed entirely to the deflection plates, which implies that d.c. components result in trace shifts on the screen.
This may cause difficulties when signals superimposed on high direct voltages have to be displayed. In order to make the a.c. signal visible in those cases, a greater attenuation will be necessary with the result that the a.c. signal will also be strongly attenuated. In this case the AC–0–DC switch can be set to position AC. Then a blocking capacitor is connected between the input socket and the Y amplifier and, therefore, not only the direct voltages but also the lower frequencies are suppressed or attenuated. When square-wave signals of low frequency are displayed, this will result in some pulse droop.
In position 0 of the AC–0–DC switch, it is possible to quickly determine the zero volt d.c. level. In this position the connection between the input socket and the amplifier is interrupted and the amplifier input earthed.

D. TRIGGERING

1. General

To display a signal, the horizontal deflection must always be started at ONE fixed point of the signal, in order to obtain a stationary trace. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit, controlled by a signal originating from the vertical input signal or an external source.

2. Trigger coupling

The LF-HF-DC switch determines the method of coupling the signal into the trigger circuit. LF coupling blocks undesired d.c. levels and h.f. interference but responds to l.f. triggering signals.
HF coupling blocks d.c. and l.f. signals, e.g. hum, but respond to h.f. triggering signals.
DC coupling makes the full signal bandwidth available for triggering.

3. Automatic triggering

Automatic triggering, when the LEVEL knob is pulled out, is most often used on account of its simple operation. In this position it is possible to display a large number of wave forms having different amplitude and shape, without it being necessary to operate any of the trigger controls. If no triggering signal is present, a time-base line remains visible on the screen. This is useful for reference purposes. In this trigger mode, the level can be adjusted over approximately 3 cm of the trace.

4. Trigger level

In case of a complicated signal in which a number of non-identical voltage shapes occur periodically, the time axis should always be started with the same voltage shape, so as to obtain a stationnary trace. This is possible when one of the details has a deviating amplitude. By means of knob LEVEL, the trigger level can then be adjusted so that only this larger voltage variation passes this level. The LEVEL setting is also useful for the study of a leading edge. Then the trigger level can be set in such way that the time-base is already started at the beginning of this leading edge, owing to the delay line.

5. External triggering

External triggering is applied for signals having a strongly varying amplitude, if a signal having a fixed amplitude and equal frequency is available. This obviates the necessity of readjusting the level setting at every variation of the input signal.

E. TIME-BASE MAGNIFIER

The magnifier is operated by a push-pull switch. When this switch is in position x5, the time-base is increased 5 times. In position x5 of the magnifier, the sweep time of the sawtooth is determined by dividing the indicated TIME/cm value by 5.

F. Z-MODULATION

In order to bring extra information in the c.r.t. display without changing the wave form, the intensity of the trace can be varied by an externally applied voltage. The external signal must, therefore, be fed to the socket Z-MOD on the rear side of the instrument. The voltage required for visible intensity modulation depends on the position of the INTENS control. With an average brightness of the trace, a 5 Vp-p voltage is amply sufficient for obtaining a good visible Z-modulation.

VI. Applications

In the following we describe the procedure and the technique for basic measurements with a PM 3210 oscilloscope.

A. VOLTAGE MEASUREMENTS

Display the waveform as large as possible in order to obtain maximum accuracy. For all voltage measurements, the AMPL. potentiometer must be in the CAL position, otherwise the deflection co-efficients are not calibrated. When using a 10:1 attenuator probe, observe that the displayed amplitude must be multiplied by a factor 10. Ensure that the probe is adjusted for good step response, and, in the interests of accuracy, that the GAIN preset of the oscilloscope is checked.

A1. Peak-to-peak voltage measurements

To measure the peak-to-peak value of the a.c. component of a waveform, connect the signal to one of the Y input sockets and adjust the Y controls to display as large a trace as possible. Then proceed as follows:

1. Set the TIME/cm switch to display a few cycles of the waveform as illustrated in Fig. 5.

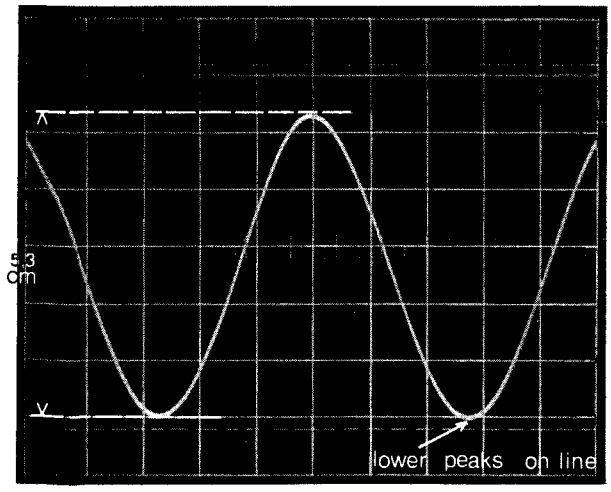


Fig. 5. Peak-to-peak voltage measurements

2. Adjust the Y POSITION control so that the lower peaks of the waveform coincide with the nearest horizontal graticule line.
3. Adjust the X POSITION control so that one of the upper peaks of the signal coincides with the central vertical graticule line.
4. Measure the vertical distance between the peaks to the signal.
5. Multiply this measured distance by the voltage setting of the Y AMPL switch and by the attenuation factor of the probe, if any.

Example:
Assume that the AMPL switch is set to 2 mV/cm and a 10:1 attenuator probe is used. The measured vertical distance is 5.3 cm.

Using the formula:

$$\text{Volts}_{p\text{-}p} = \left(\begin{matrix}\text{vertical}\\ \text{distance}\end{matrix}\right) \times \left(\begin{matrix}\text{AMPL}\\ \text{setting}\end{matrix}\right) \times \left(\begin{matrix}\text{probe}\\ \text{attenuation}\end{matrix}\right)$$

$$= 5.3 \times 2.10^{-3} \times 10$$

$$= 106.10^{-3} = 106 \text{ mV}$$

If the waveform is purely sinusoidal, the r.m.s. voltage is:

$$V_{r.m.s.} = \frac{V_{p\text{-}p}}{2\sqrt{2}} = \frac{106.10^{-3}}{2\sqrt{2}} = 38.2 \text{ mV}$$

A2. Instantaneous voltage measurements

To measure the instantaneous value of a waveform, connect the signal to one of the Y input sockets and adjust the Y controls to display as large a trace as possible. Then proceed as follows:

1. Set the Y input switch to 0 and adjust the Y POSITION control so, that the zero reference line coincides with the nearest horizontal graticule line.

   NOTE: The Y POSITION control must not be moved after this reference line has been established.
2. Set the Y input switch to DC.
3. If desired, rotate the X POSITION control so that the point to be measured lies on the vertical centre line.
4. Measure the vertical distance between this point and the zero-reference line; if the point lies above the reference line, the voltage is positive; if the point lies below the line, the voltage is negative. (Make sure that the INVERT switches are in NORMAL position.)
5. Multiply the measured distance by the voltage setting of the Y AMPL switch and the attenuation factor of the probe, if any.

Example:
Assume that the Y AMPL switch is set to .1 V/cm and that a 10:1 attenuator probe is used. The measured vertical distance is 5 cm (Fig. 6).

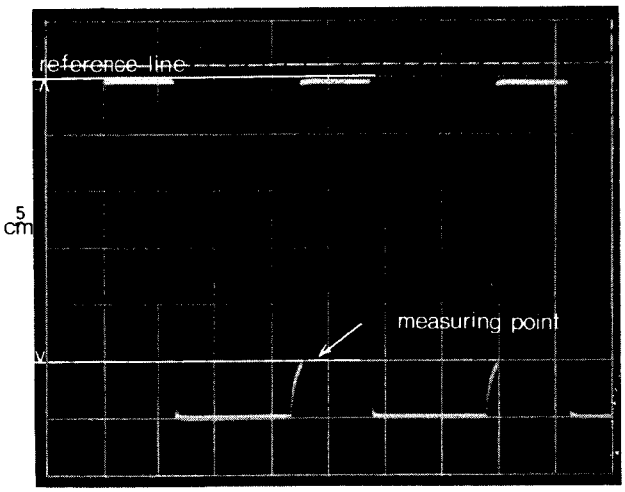


Fig. 6. Instantaneous voltage measurements

Using the formula:

$$\text{Instantaneous voltage} = (\text{vertical distance}) \times (\text{Y AMPL setting}) \times (\text{probe attenuation})$$

$$= 5 \times 10^{-1} \times 10$$

$$= 5 \text{ V, of negative polarity}$$

NOTE: To measure a voltage level with respect to another voltage rather than to earth, apply the reference voltage to the input socket. Adjust the Y POSITION control, so that the trace coincides with a horizontal graticule line, which can now be used as the reference line. This replaces the zero-reference procedure described in step 1.

B. TIME AND FREQUENCY MEASUREMENTS

For all time and frequency measurements, the TIME/cm potentiometer must be in the CAL position, otherwise the sweep speeds are not calibrated.

B1. Time measurements

To measure the time interval between two points of a waveform, connect the signal to one of the Y input sockets and adjust the Y controls to display as large a trace as possible.
Then proceed as follows:

1. Set the TIME/cm switch so that the horizontal distance between the time-measuring points is as large as possible.
2. Rotate the X POSITION control so that one of the measuring points coincides with the nearest vertical graticule line.
3. Rotate the Y POSITION control to bring the other point to the horizontal centre line.
4. Measure the horizontal distance between the two time-measuring points.
5. Multiply the measured distance by the TIME/cm setting (if magnification is used, divide this product by 5).

Example:
Assume that the TIME/cm setting is .5 μs and the magnifier is on. The measured distance is 8.2 cm (Fig.7).

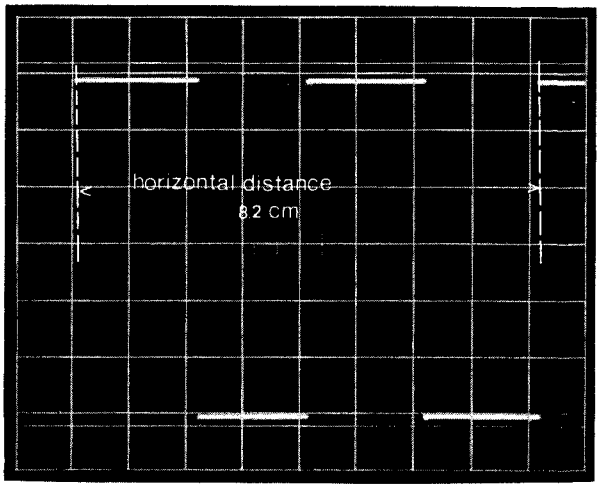


Fig. 7. Time measurements

Using the formula:

$$\text{Time interval} = \frac{\text{horizontal distance} \times \text{TIME/cm setting}}{\text{magnification}}$$

$$= \frac{8{,}2 \times 5.10^{-7}}{5}$$

$$= 0.82\ \mu\text{s}$$

After measuring the time duration of one cycle in the way described above, the frequency can be easily calculated:

$$\text{frequency} = \frac{1}{\text{time-duration of one cycle}}$$

B2. Rise-time measurements

Rise-time is defined as the time required by the leading edge of a signal to rise from 10 % to 90 % of the amplitude.
When the oscilloscope rise-time is comparable with the signal under test, the actual rise-time should be calculated as follows:

$$\text{actual } t_r = \sqrt{(\text{measured } t_r)^2 - (\text{oscilloscope } t_r)^2}$$

This calculation is not necessary when the signal rise-time is longer than 50 ns (the error is then 5 % and decreases rapidly when the rise-time becomes longer).
To measure the rise-time of a signal, connect the signal to one of the Y input sockets and adjust Y controls to display as large a trace as possible.
Then proceed as follows:

1. Set the TIME/cm switch to display the total voltage step on the screen.
2. Adjust the Y amplitude so that the vertical deflection is exactly 8 cm.
   The 10 and 90 % points now coincide with the dotted lines of the graticule.
3. Adjust the X POSITION control so that the 10 % coincides with the nearest vertical graticule line; this line is now the time reference line, and no further adjustment of the X POSITION control should be made.
4. Measure the horizontal distance between the time-reference line (coincident with the 10 % point) and the point of intersection of the signal and the horizontal 90 % line.
5. The rise-time is given by the product of the horizontal distance in centimetres and the TIME/cm setting. If magnification is used, this product must be divided by 5.

Example (Fig. 8):
Assume that the TIME/cm setting is 200 ns and magnification is used. The oscilloscope rise-time is 14 ns.
The measured distance is 0.6 cm.

$$\text{Measured rise-time} = \frac{\text{TIME/cm setting x Horizontal distance}}{\text{Magnification}}$$

$$= \frac{2.10^{-7} \times 6.10^{-1}}{5} = 24 \text{ ns}$$

Substituting in the formula:

$$\text{actual rise-time} = \sqrt{(\text{measured rise-time}^2 - \text{oscilloscope rise-time}^2)}$$

$$= \sqrt{576 - 196} = \sqrt{380} = 19.5 \text{ ns}$$

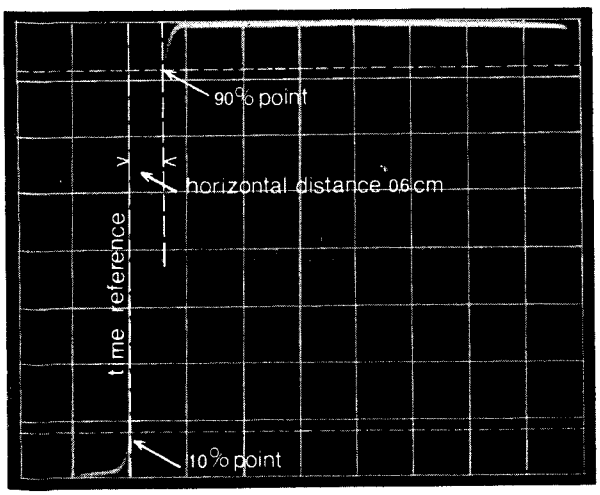


Fig. 8. Rise time measurements

C. PHASE MEASUREMENTS

To measure the phase difference between two sinusoidal signals of the same frequency, use the following method. Connect one signal to one of the Y input sockets and the other signal to the other Y input socket, using probes or coaxial cables **with equal time delays**. Display the traces using the AUTO mode of the time-base with the Y display-mode switch at CHOPPED (suitable for low frequencies) or ALTERN. (suitable for high frequencies). If the signals are of opposite polarity then pull one of the Y position controls to invert the lagging signal. Note that the total phase difference must be subtracted from 180° in this event. With a stable display of maximum amplitude, adjust the Y POSITION controls for symmetry about the horizontal centre-line.
When you have set up the display, proceed as follows:

1. Set the TIME/cm switch and potentiometer so that one cycle of the first signal occupies exactly 8 cm horizontally; i.e. each cm represents 360°/8 = 45°.
2. Measure the horizontal distance between the two corresponding points on the waveforms, and multiply this by 45° to obtain the phase difference.
   If one of the Y POSITION controls is pulled, subtract the result from 180°.

   NOTE: For small phase difference (less than 45°) use the x5 MAGN. push-button and divide the result by 5. The phase scale is now 9°/cm, therefore, the measured distance in centimetres should be multiplied by 9 to obtain the desired phase difference measurement.

D. X-Y MEASUREMENTS

The X-Y measuring method can be used for making phase measurements, frequency measurements, hysteresis measurements or for using the oscilloscope as a vector scope.

D1. Phase measurements

To measure the phase difference between two sinusoidal signals of the same frequency, use the following method: Connect one signal to one of the Y input sockets and the other signal to the other Y input socket, using probes or coaxial cables **with equal time delays**. Set the Y display-mode switch to X-Y and adjust the Y controls to display as large a trace as possible. Then proceed as follows:

1. centre the display;
2. measure the distances **a** and **b** (see Fig. 9);
3. the sine of the phase angle is given by a/b. The phase angle can now be obtained from a trigonometric table.
   When a phase graticule is used, the phase difference can be read at once.

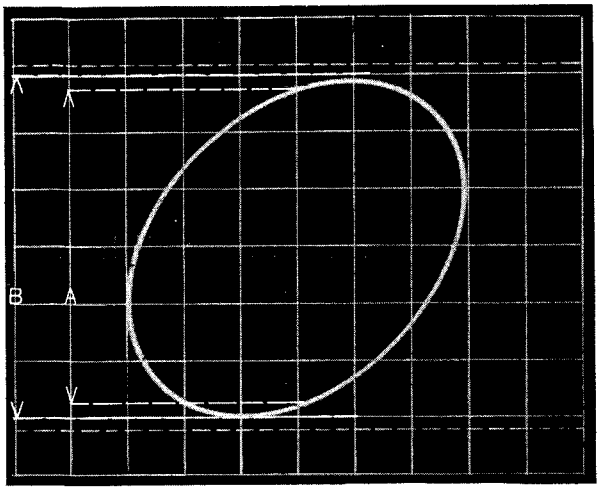


Fig. 9. Phase measurements, X Y method

D2. Frequency measurement

To measure frequencies, a signal with a known, adjustable frequency must be connected to input socket Y_B. The signal with the frequency to be measured must be applied to socket Y_A. Set the Y display-mode switch to X-Y and proceed as follows:

1. adjust the known frequency to obtain a stable display;
2. imagine a horizontal and vertical tangent to the obtained Lissajous figure;
3. count the points of contact n_X of the trace and the vertical tangent and the points of contact n_Y of the trace and the horizontal tangent. If the Lissajous figure is not closed, the point of contact of the tangent with the open figure must be taken into account as half a point of contact.

Example:
Assume that $n_X = 4$, $n_Y = 3$ and that the known frequency is 500 Hz (see Fig. 10).

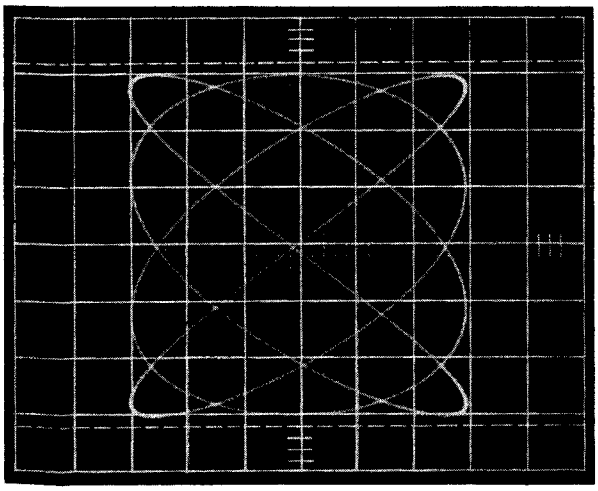


Fig. 10. Frequency measurements

Using the formula:

$$\text{unknown frequency} = \frac{n_Y}{n_X} \text{ (known frequency)}$$

$$= 3/4 \times 500$$

$$= 375 \text{ Hz}$$

E. Y OUTPUT SIGNAL

Many advantages accrue from the fact that in this oscilloscope the internal triggering signal can be derived from either channel and is taken off before the electronic switch. The main advantages are:

- the trigger signal is merely a part of the input signal and is, therefore, devoid of interfering components such as are present in the chopped mode and may result in display instability;
- in the alternate mode, the possibility of time relationship errors between the displayed waveforms is avoided since the trigger signal is not a combination of two or more signals;
- the triggering is unaffected by the continuous AMPL. controls and the SHIFT/polarity controls of the Y amplifiers;
- a simple method is provided for triggering from either channel without the necessity of changing input connections or applying one of the signals to the external trigger input.

In this way misleading displays are prevented and a stable display is obtained very easily.
Sometimes, however, it may be necessary to display two signals with unrelated frequencies. External triggering with the Y signal of socket Y OUT, will then provide a stable display, when the instrument is operated in the ALTERN. mode.

Example:
Assume that you want to adjust a frequency to be a certain ratio of an accurately known frequency. Suppose that the known frequency is exactly 2 MHz and that the other frequency has to be adjusted to 5 MHz.

- Set the time base to display about 3 complete cycles of the 2 MHz signal.
- Set the display switch to position ALTERN.
  The input signals will be present at the Y output socket alternately for a complete sweep time.
- Connect the Y output socket to socket TRIGG (IU1).
  The d.c. level of each signal can be varied by means of the relevant SHIFT control.

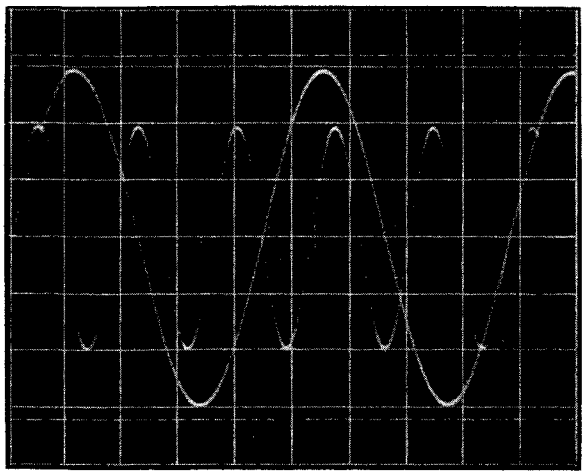


Fig. 11. Using the Y output signal

- Set coupling selector LF-HF-DC (SK2) to DC or HF to obtain stable triggering.
- Adjust LEVEL (R1) so that the sweep starts for both signals on the horizontal centre line of the graticule.

The frequency can now be adjusted to the desired value by making the end of the fifth cycle coincide with the end of the second cycle of the known frequency, as shown in Fig. 11.
This method is extremely accurate since measurements are independent of time-base inaccuracies.

VII. Brief checking procedure

This check should be performed with a nominal mains voltage.

Preliminary settings of the controls

- AC–0–DC (SK9/SK11) to position 0.
- Display switch SK10 to position CHOPPED.
- TIME/cm (SK6) to position 1 ms.
- Pull LEVEL (SK5) to position AUTO.
- Set SHIFT (R13/R14) and INTENS (R2) for two time-base lines.
- Set AMPL. (R8/R9) and TIME/cm (R13) to position CAL.
- Set AMPL. (SK12/SK13) to position 50 mV.

Unless otherwise stated, the controls should occupy these positions during all the following checking procedures.

Make sure that the instrument had a warming up time of half an hour before attempting any re-adjustment.

General check

- TIME/cm (SK6) to position 50 ms.
- Check the proper working of display switch SK10: Y_A, CHOPPED, ALTERNATE, ADDED, X–Y, Y_B.
- AC–0–DC (SK9) to position 0.
- Apply a sine-wave signal of a low frequency to socket Y_A (BU3).
- Adjust AMPL. (SK12) for a trace height of 6 cm.
- Check astigmatism; if necessary re-adjust potentiometer R1044 (Fig. 12).
- Check that the trace runs in parallel to the horizontal centre line of the graticule; if necessary re-adjust the trace rotation potentiometer R1048 (Fig. 13); the trace must be in the centre of the graticule during this adjustment.

Y amplifier

- Display-switch SK10 to position Y_A.
- Check that the trace does not move when switch AMPL. (SK12) is rotated between positions 50 mV/cm and 1 mV/cm; if necessary re-adjust DC BAL (R10).
- AMPL. (SK12) to position 1 mV/cm.
- Switch AC–0–DC (SK9) over from 0 to DC. The trace should not shift; if necessary re-adjust potentiometer R143 (Fig. 14).
- Check the deflection co-efficients of channel A; tolerance + or –3 %. If necessary re-adjust GAIN ADJ. (R9).
- Display-switch SK10 to position Y_B.
- Check that the trace does not move when switch AMPL. (SK13) is rotated between positions 50 mV/cm and 1 mV/cm; if necessary re-adjust DC BAL (R10).
- AMPL. (SK13) to position 1 mV/cm.
- Switch AC–0–DC (SK11) over from 0 to DC. The trace should not shift; if necessary re-adjust potentiometer R343 (Fig. 13).
- Check the deflection co-efficients of channel B; tolerance + or –3 %. If necessary re-adjust GAIN ADJ. (R12).
- Display-switch SK10 to position X Y.
- Check the deflection co-efficients of channel B in X direction; if necessary re-adjust potentiometer R944 (Fig. 12).
- Check the amplitude and phase equality between X and Y amplifier up to a frequency of 5 MHz. The deviation of the amplitude equality should not exceed 2 %; if necessary correct with trimmer C906 (Fig. 12). The phase difference should not exceed 2°; if necessary correct with potentiometer R946 (Fig. 12).

Time-base generator

- Check the triggering with a sine-wave signal at a frequency of 25 MHz and a trace height of 3 cm.
- Check the sweep time in position 1 ms/cm; tolerance + or –3 %. If necessary re-adjust potentiometer R833 (Fig. 12).

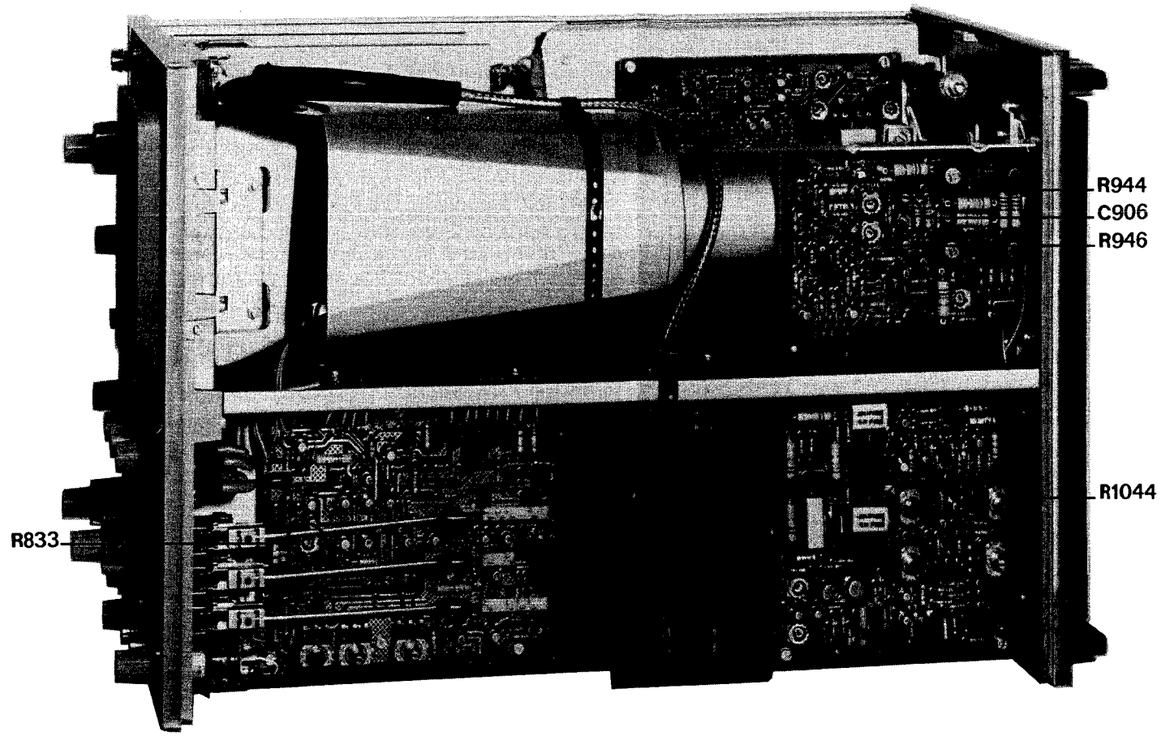


Fig. 12. Adjusting elements

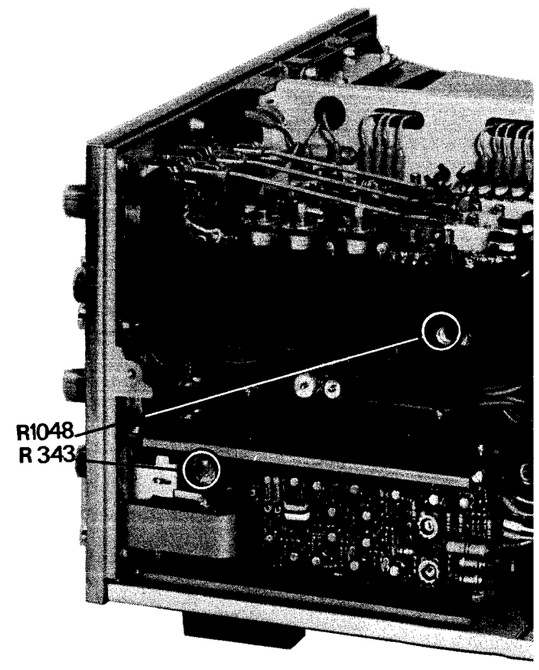


Fig. 13. Adjusting elements

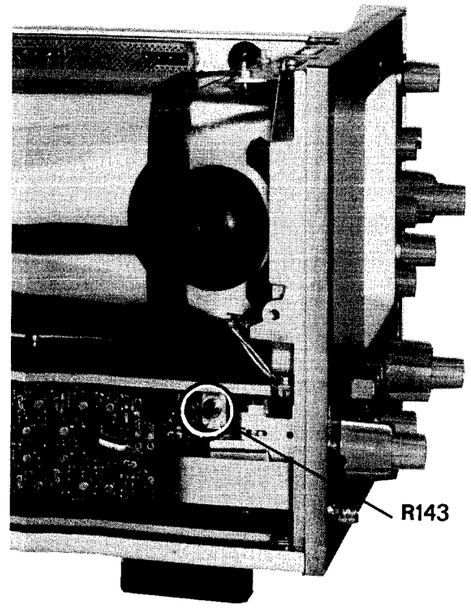


Fig. 14. Adjusting elements

IV. Installation

The PM 3210 oscilloscope is despatched complete with the following accessories which are stowed, for transit, in the packing spaces in front of and behind the instrument. These items are:

1. two BNC-4 mm adapters PM 9051
2. a green filter
3. an instruction manual
4. a viewing hood PM 9366
5. a trimming rod
6. a coaxial cable PM 9074

On receipt, remove these accessories and the instrument from the carton and examine them to ascertain whether any damage has been sustained in transit.
Remove the cover by means of the two screws with which the handle is attached and the two screws near the rear panel. Check that all printed-circuit cards are fully inserted and visually inspect the interior.
Replace the cover.

A. MAINS ADJUSTMENTS AND FUSES

Before switching on, the instrument should be adjusted to the local mains voltage by means of the voltage adapter inside the instrument.
Provision is made for selecting 110 V, 125 V, 145 V, 200 V, 220 V and 245 V. The voltage selected is displayed through an aperture at the right-hand side of the instrument. The mains-voltage adapter can be set after removal of the cover.
The fuse-holder on the rear panel normally carries a 1 A delayed-action mains fuse but if the instrument is to be connected to a mains voltage of less than 200 V, a 2 A fuse should be fitted.

A thermal cut-out is incorporated as an integral part of the mains transformer to prevent excessive over-heating in the case of a prolonged short circuit.

B. EARTHING

In the interests of safety, the instrument should be earthed via the earth terminal ⏚ on the front panel, the earth screw ⏚ on the rear panel, or via the mains flex if this has a plug with an earth connection.

NOTE: Double-earthing must be avoided as this may cause hum on the trace.

C. SWITCHING ON

The instrument is switched on by means of the POWER ON switch. The white pilot lamp illuminates to indicate this condition when the mains are connected and the POWER ON switch is in the "up" position.
The instrument can be used in horizontal, vertical or tilted position, but care should be taken that a free air circulation is not impeded. For temperature conditions refer to chapter II.

WARNING:
This instrument generates high voltages and should not be operated with the covers removed. The mains plug should be removed before attempting any maintenance work, and any relevant high voltage points discharged.
Never switch on the instrument when any printed-circuit card has been removed and never remove any printed-circuit card when the instrument is switched on.

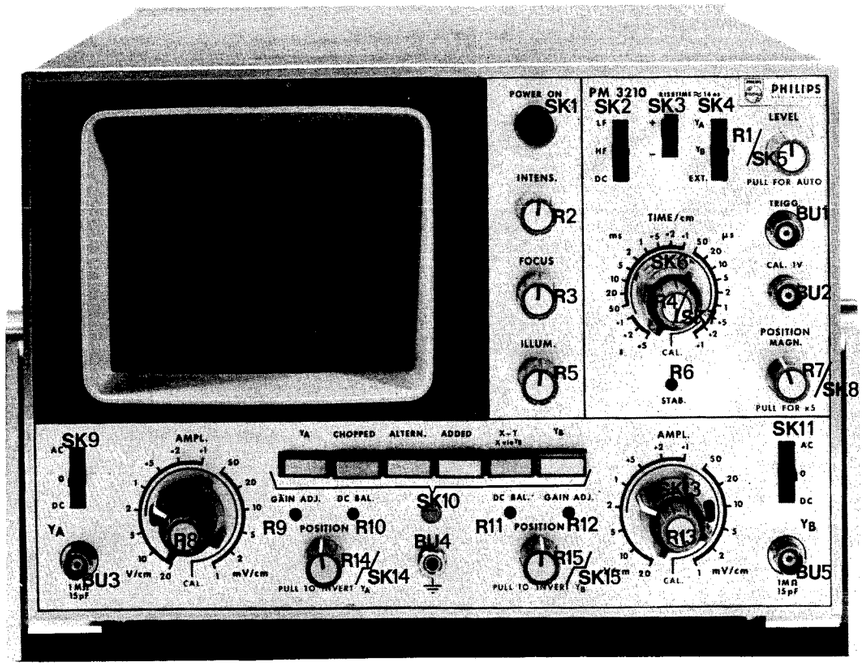


Fig. 3. Controls and sockets, front

Fig. 4. Sockets, rear

V. Operating instructions

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with chapter IV. INSTALLATION, and that the precautions outlined have been observed.

A. CONTROLS AND SOCKETS (Fig. 3)

Time-base generator

LF–HF–DC (SK2) — trigger coupling, three-position switch:

- LF : via a band-pass filter for frequencies from 10 Hz to 10 kHz.
- HF : via a high-pass filter for frequencies above 10 kHz.
- DC : direct coupling for triggering on a slowly varying voltage, or for full bandwidth working.

+/– (SK3) — slope control, two-position switch:
provides for triggering on the positive-going or the negative-going slope of the signal.

Y_A–Y_B–EXT (SK4) — trigger source, three-position switch:

- Y_A : trigger signal derived from channel A
- Y_B : trigger signal derived from channel B
- EXT: trigger signal derived from a voltage applied to the TRIGG. BNC socket

LEVEL (R1/SK5) — continuously adjustable control to select the level at which the time-base triggers. Incorporates a switch for position AUTO in which the time-base is free-running in the absence of trigger signals. The level range in position AUTO is reduced.

TIME/cm (SK6) — time coefficient control of the time-base, 21-way switch.

CAL-TIME/cm (R7/SK7) — continuously variable control of the time coefficients. In the CAL-position the time coefficient is calibrated.

TRIGG. (BU1) — input BNC socket for external triggering signals.

STAB. (R6) (screw-driver operated) — continuously variable control of the time-base stability.

SHIFT (R7) — continuously variable control giving horizontal positioning of the display.

MAGN. (SK8) — push-button control for x5 magnification of time-base.

Vertical channels

A–CHOPPED–ALTERN–ADDED–XY–B (SK10) — display mode, 6-way push-button switch:

- A : Vertical deflection is achieved by the signal connected to channel A input.
- CHOPPED : the display is switched over from one vertical channel to the other at a fixed frequency.
- ALTERNATE : the display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal.

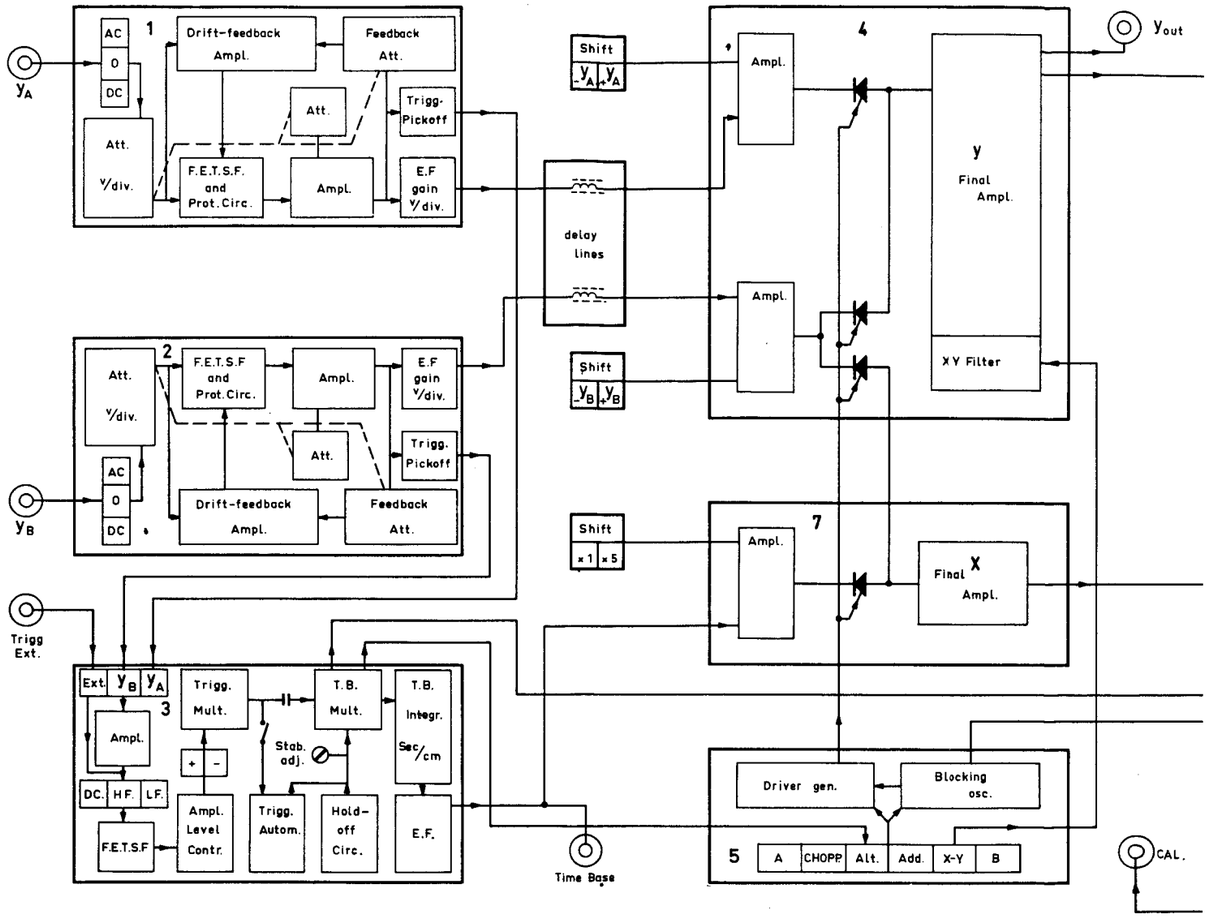
time-base sweep.
The output pulse of this oscillator controls the driver generator.
In positions A, B, ADDED and X-Y the blocking oscillator is inoperative; the driver generator is then controlled by the push-button switch.

3. The driver generator, which supplies voltages required to obtain the different positions of the diode switch.

THE COMBINATION UNIT

This unit comprises the following circuits.

1. The unblanking circuit which unblanks the c.r.t. during the sweep of the time-base.
2. The blanking circuit which suppresses the beam during the switching between channels A and B.
3. The external Z-modulation circuit.
4. The calibration-voltage generator.
   This generator provides a square-wave voltage of 1 V ±1 % at a frequency of about 2.5 kHz.
5. Graticule-illumination circuit, which provides a graticule illumination which is independent of mains-voltage variations.
6. Voltage stabilizer, which keeps the 23 V input voltage of the converter at a constant value during mains-voltage and load variations.
   The stabilizer provides together with unit 10 (mains-voltage transformer + rectifier) and the series regulator on the rear of the instrument, the supply voltage for the converter.
7. Connector unit 6. This unit consists of a square-wave converter with a frequency of about 18 kHz.
   The power pack provides all supply voltages for the instrument, viz. + and −23 V, + and −95 V, −1600 V and +8500 V.



calibration-voltage generator.
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+8500 V.

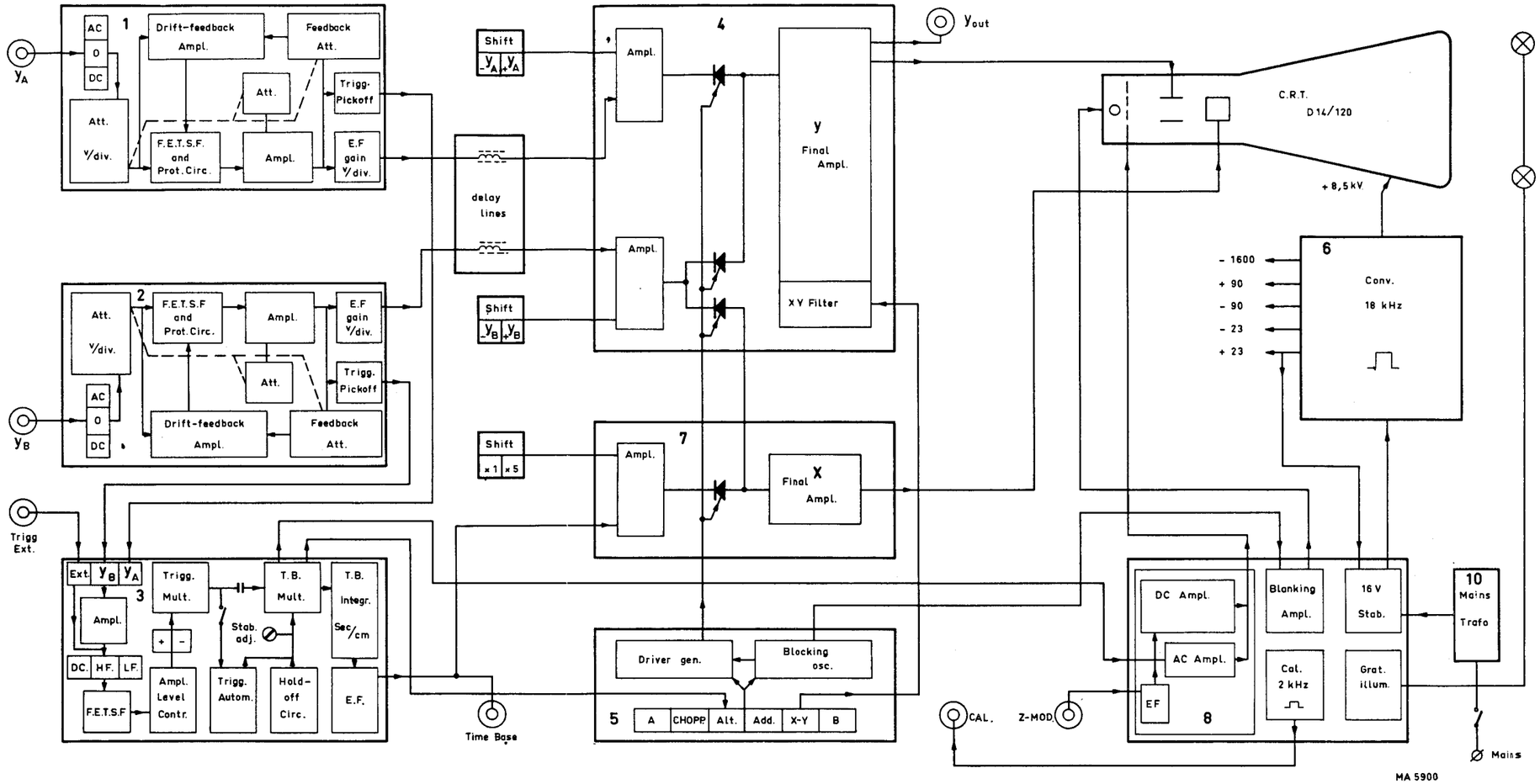


Fig. 2. Block diagram

SK10 CHANNEL A SELECTED

A +23V CH B ALT ADD X-Y +23V B

R529 R444

R922 R518 R527 +23V R521 R453 R518 R615 -23V R519

+23V

R501 22 100K C501

R507 1K R508 2K2 R509 1K

GR501 BAX13 +17,3V GR502 BAX13

BZY88C4V7 GR503

R502 33 R522 33

C502 22 C503 22

TS501 BC107 R504 1K R511 5K6 +12,7V R514 5K6 +17,9V R523 1K TS504 BC107

+12V +17,2V R448

R1446

TS502 BSX20 R512 33 +13,4V +11,7V R516 33 TS503 BSX20

R503 1K8 R506 5K6 R513 68K R517 68K R524 5K6 R526 1K8

+12,6V

11-SK10

T501

S3 S4 S1 S2

BAX13 GR511 R535 470 R530 51 0V R1026

R532 33 C509 330 R816

TS507 BSX20 -21,8V -0,4V -23V

R527 5K6 R528 270 100K C507 5K6 R529 470 100K C508 R531 560 R533

-18,4V

+13,2 GR504 BAX13 +13,7V +11,7V GR506 BAX13 +17,9V

33 C504 R518 1K GR507 BZY88C12 R519 1K 33 C506

0V L501 1K R525

C505 68

TS506 BCY70 R536 33 +23V

14-SK10 R521

-21,8V R534 150 C511 100K

+23V 330 C514 R537 560

R538 150 100K C513 100K C512

C516 100K +23V -23V

23-SK10

GR508 BAX13 GR509 BAX13 +23V +11,7V

-21,5V

6-SK10 29-SK10 R521 100K 35-SK10

R534

MA5975

25MC DUAL TRACE SCOPE

SWITCHING UNIT

PM3210/02

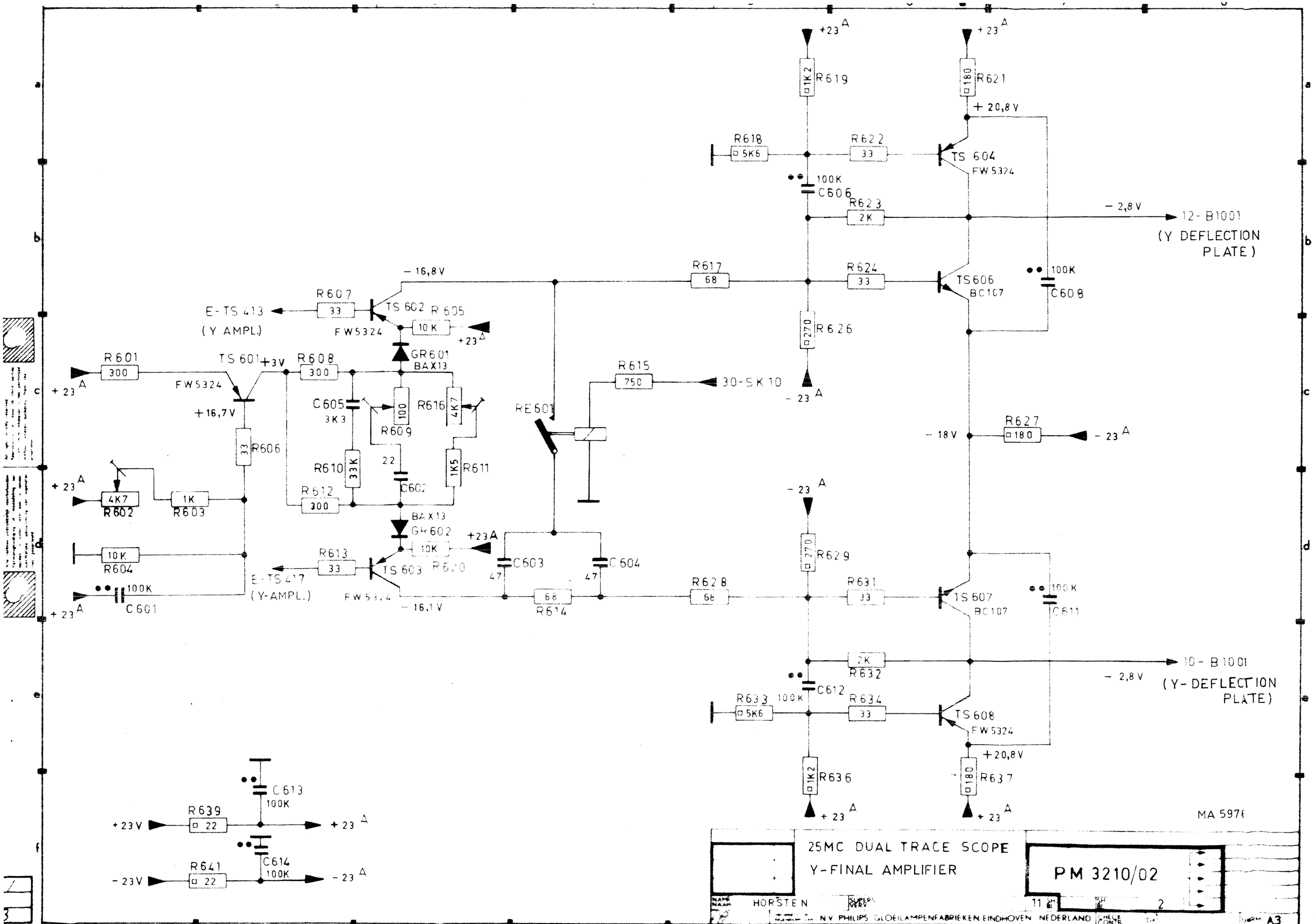
NAME HORSTEN

N.V. PHILIPS GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND

FORM A3

MA5975

2822 100 02041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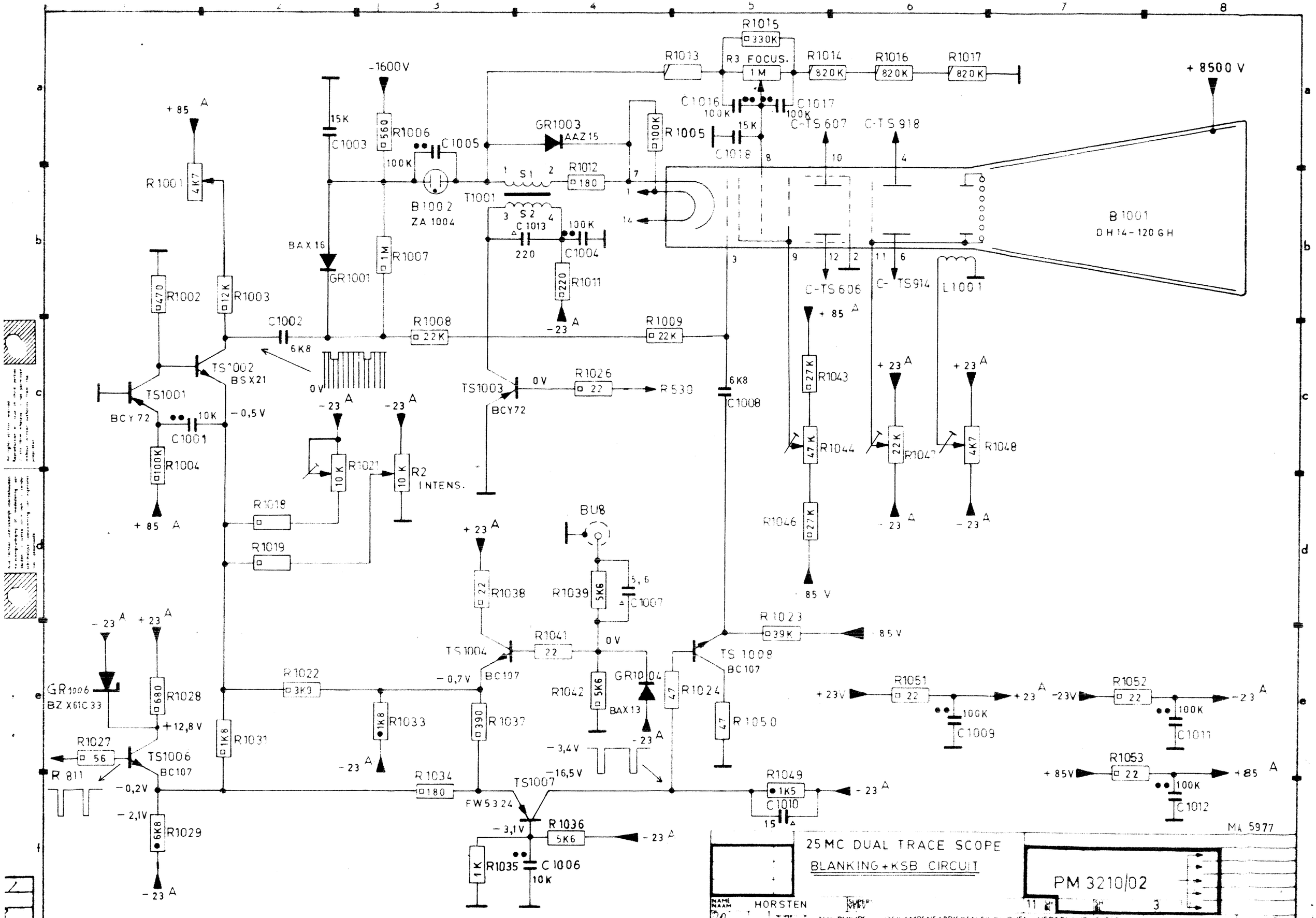
R619
1K2
+23 A
R621
180
+ 20,8 V
R618
5K6
R622
33
TS 604
FW5324
100K
C606
R623
2K
– 2,8 V
12- B1001
(Y DEFLECTION PLATE)
– 16,8 V
R617
68
R624
33
TS606
BC107
100K
C608
R607
33
E-TS 413
(Y AMPL.)
TS 602
FW5324
R 605
10 K
+23 A
GR601
BAX13
R626
270
R601
300
+23 A
TS 601
+3V
R608
300
FW5324
+16,7 V
C605
3K3
R609
100
R616
4K7
R615
750
30-SK10
– 23 A
RE601
R606
33
R610
33K
22
C602
R611
1K5
R627
180
– 18 V
– 23 A
+ 23 A
4K7
R602
1K
R603
R612
300
BAX13
GR602
10K
+23A
10K
R604
R613
33
TS 603
R620
E-TS 417
(Y-AMPL.)
100K
C601
+ 23 A
FW5324
– 16,1 V
C603
47
C604
47
68
R614
R628
68
– 23 A
R629
270
R631
33
TS 607
BC107
100K
C611
2K
R632
10 - B 1001
– 2,8 V
(Y- DEFLECTION PLATE)
C612
R633
5K6
100K
R634
33
TS 608
FW 5324
+20,8 V
1K2
R636
180
R637
+ 23 A
+ 23 A
C613
100K
R639
22
+23 V
+ 23 A
C614
100K
R641
22
– 23V
– 23 A
MA 5976
25MC DUAL TRACE SCOPE
Y-FINAL AMPLIFIER
PM 3210/02
HORSTEN
11
2
N.V. PHILIPS GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND
A3


R1015
330K
R1013
R3 FOCUS.
1M
R1014
820K
R1016
820K
R1017
820K
+ 8500 V
C1016
100K
C1017
100K
C-TS 607
C-TS 918
-1600V
+ 85 A
15K
C1003
560
R1006
C1005
100K
GR1003
AAZ15
100K
R1005
15K
C1018
R1001
4K7
S1
R1012
180
T1001
B1002
ZA 1004
S2
C1013
220
100K
C1004
B1001
DH14-120GH
BAX16
GR1001
1M
R1007
220
R1011
-23 A
C-TS 606
C-TS 914
L1001
470
R1002
12K
R1003
C1002
6K8
R1008
22K
R1009
22K
+ 85 A
R1043
27K
+ 23 A
+ 23 A
TS1002
BSX21
TS1001
BCY72
10K
C1001
-0,5V
0V
-23 A
-23 A
TS1003
BCY72
0V
R1026
22
R530
6K8
C1008
100K
R1004
10K
R1021
R2
INTENS.
R1044
47K
22K
4K7
R1048
R1018
R1019
+ 85 A
R1046
27K
-23 A
-23 A
-85 V
BU8
+ 23 A
22
R1038
R1039
5K6
5,6
C1007
R1023
39K
-85V
-23 A
+ 23 A
R1041
22
TS1004
BC107
0V
TS1008
BC107
-0,7V
R1022
3K3
R1042
5K6
GR1004
BAX13
47
R1024
47
R1050
GR1006
BZ X61C33
680
R1028
+12,8V
R1033
1K8
R1037
390
-23 A
-3,4V
-16,5V
-23 A
R1027
56
TS1006
BC107
R1031
1K8
R1034
180
TS1007
FW5324
R1049
1K5
C1010
15
-23 A
R 811
-0,2V
-2,1V
6K8
R1029
-3,1V
R1036
5K6
-23 A
1K
R1035
C1006
10K
-23 A
R1051
22
+23V
+ 23 A
100K
C1009
R1052
22
-23V
-23 A
100K
C1011
R1053
22
+85V
+85 A
100K
C1012
MA 5977
25MC DUAL TRACE SCOPE
BLANKING + KSB CIRCUIT
PM 3210/02
NAME HORSTEN
N.V. PHILIPS

SK 16
POS. 220V

T1101

T1102
C 1100
100 K
T1103

S1'b
S1'a
S1
S2
S3

VL1

POWER ON

SK1 N VL1101

1 → B1001
14 → B1001

T1101					
COIL	S1	S1'a	S1'b	S2	S3
VOLTS	110	20	15	6,3	22

BYX 21-200
BYX 21-200R
GR1101
GR1102
GR1103
GR1104
C1101 1500 µF
C 1110 1 µF

R1102 100K
R1103 4,7
R1108 1K

1V
+ 22,3V
+14,6V

TS1102 BDY38
TS1103 BFY52
R1107 120

C 1105 100K

La1 La2 La3

C1102 6,8µF
C1103 5K6

+23V

L1201 (CONVERTOR)

R1116 1,5K
R1117 3K9
R1118 27
R1121 4K7

+16V

VL1101

SCREEN

T 1101

+23V
C1106 6,8 uF
R1122 750
+15,3V

C1107 33K
R1123 820K
R1126 3K9
C1109 22K
R1132 3K9
R1127 1K5
R1128 2K2

TS1108 BSX20
TS1109 BSX20

C1111 100K
R1133 270

+0,7V
-10,4V
-6,4V

C1108 6,8 µF
R1129 560
R1131 3K9
R1136
R1134 12K
C1112 1K

R1124 750
-23V
-15,4V

GR1107 BZY88/C6V8

Bu2 CAL. 1V

R1137 2K2
R1138

R1114 1K
R1113 4K7

+5,4V
TS1106 BC107
TS1107 BC107
+4,8V
+5,4V

R1112 39
R1111 39
R5 ILLUM. 4K7
TS1104 BFY52

R1119 1K8
C1104 220K
GR1106 BZY88/C5V6

MA5 978

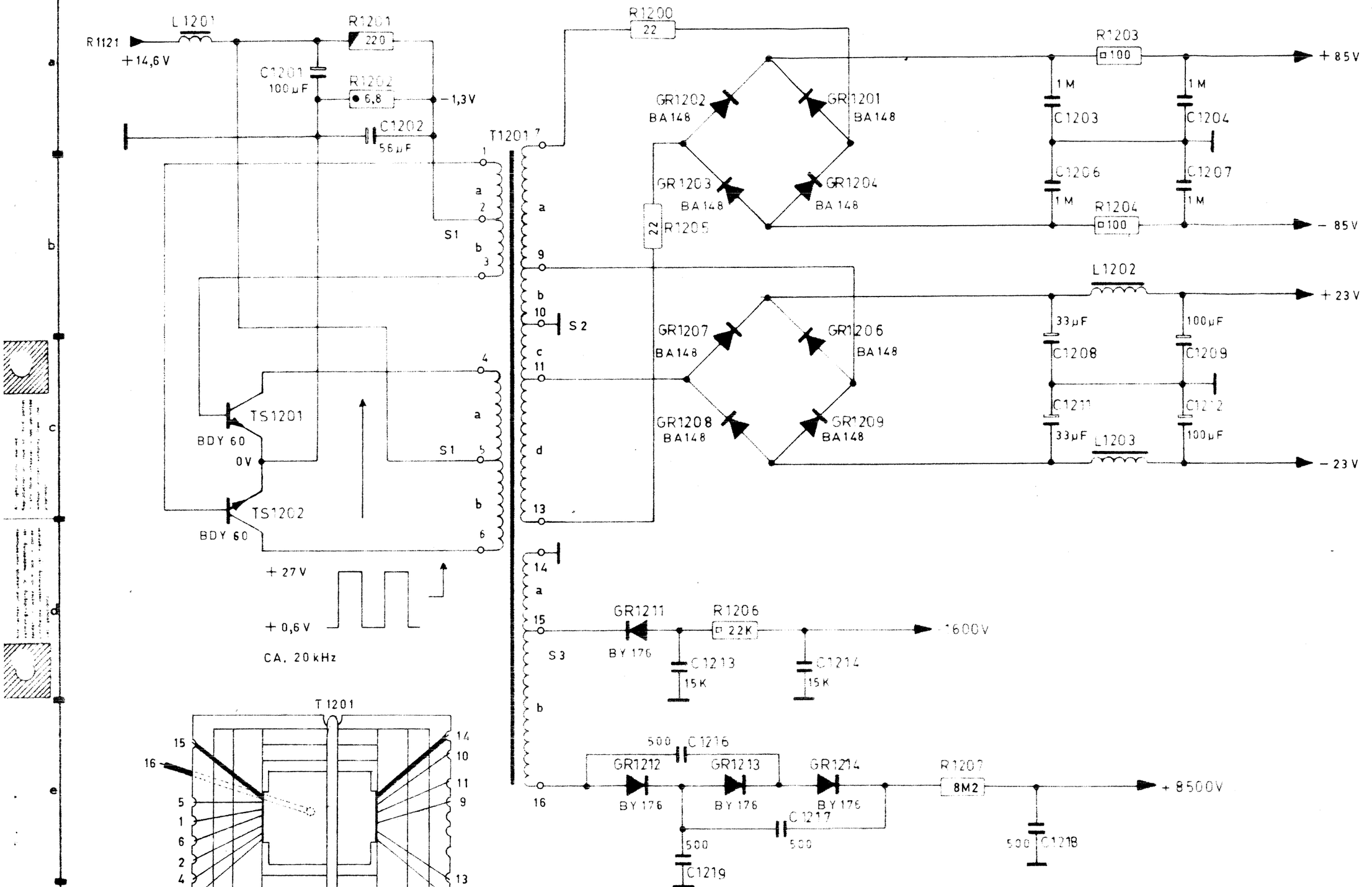
25 MC DUAL TRACE SCOPE
STAB. POWER SUPPLY
+CAL. UNIT.

PM 3210|02

NAME ØRSTEN

N.V. PHILIPS' GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND

FORM A3



COIL	S1a	S1b	S1'a	S1'b	S2a	S2b	S2c	S2d	S3a	S3b
TURNS	5	5	1	1	26	9	9	26	535	400

MA 5979

25MC DUAL TRACE SCOPE

CONVERTER UNIT

PM3210/02

NAME NAAM HORSTEN

N.V. PHILIPS' GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND

A3

DELAY LINE
T402
T401
R322
ATT.
SK15
R15
POSITION
R401 220
R408 33
TS401 BSX20
R416 100
R417 33
TS403 BC107
R424 33
C411 820
R426 1K2
R427 4K7
R409 4K7
R407 47K
R406 56K
R411 100
C402
C403
C404 330
C406 47
R429 470
R428 180
R435 9K1
R431 2K2
R432 10K
R433 4K7
R403 33
TS402 BSX20
R418 33
TS404 BC107
R434 33
R436 1K2
C412 820
R412 4K7
R404 33K
C401 100K
R402 330
R414 9K1
R413 9K1
R419 3K
R421 2K2
R422 3K
R423 2K2
R437 33
R438 33
R439 33
R441 33
TS406 BC107
TS407 BC107
TS408 BC107
TS409 BC107
R442 33
R443 33
25-SK10
GR403 BAX13
R446 47
GR912
R448 33
R444 100K
GR404 BAX13
C405 100K
R447 47
GR911
R449 33
TS411 BC107
TS412 BC107
GR406 BAX13
GR407 BAX13
R451 4K7
R452 4K7
GR408 BAX13
GR409 BAX13
E-TS 504
R481 33
R482 33
R483 33
R484 33
C416 100K
C415 100K
C417 100K
C420 100K
R461 10K
R462 33
TS 413 FW5324
C413 1
R456 2K05
R463 33
R607
TS 414 FW5324
C409 8,2
R453 2K37
R457 750
R455 10K
24 SK10
R464 1K8
GR411 BAX13
R454 2K87
R458 715
TS 416 FW5324
R459 2K05
C414 1
R467 33
TS 417 FW5324
R466 10K
R468 33
R465 1K
R613
R450 48K7
BU 7
R486 22
C418 100K
R487 22
C419 100K

T1402
T1401
R122
ATT
SK14
R14
POSITION
R1401 220
R1408 33
TS1401 BSX20
R1416 100
R1417 33
TS1403 BC107
R1424 33
C1411 820
R1426 1K2
R1427 4K7
R1409 4K7
R1407 47K
R1406 56K
R1411 100
C1402
C1403
C1404 330
C1406 47
R1429 470
R1428 180
R1435 9K1
R1431 2K2
R1432 10K
R1433 4K7
R1403 33
TS1402 BSX20
R1418 33
TS1404 BC107
R1434 33
R1436 1K2
C1412 820
R1412 4K7
R1404 33K
C1401 100K
R1402 330
R1414 9K1
R1413 9K1
R1419 3K
R1421 2K2
R1422 3K
R1423 2K2
R1437 33
R1438 33
R1439 33
R1441 33
TS1406 BC107
TS1407 BC107
TS1408 BC107
TS1409 BC107
R1442 33
R1443 33
GR1406 BAX13
GR1407 BAX13
GR1408 BAX13
GR1409 BAX13
E-TS501
R1444 33
R1446 33
TS1411 BC107
R1447 2K2

MA5980

25MC DUAL TRACE SCOPE
Y-AMPL.
PM 3210/02
HORSTEN
N.V. PHILIPS GLOEILAMPENFABRIEKEN, EINDHOVEN - NEDERLAND
A2

BU 3
BU 4
R 26 33
R 27 100
SK9 CLOSED IN POS.
AC
3 DC
100K C26
C25 3,3
C27 27
R28 200K
SK12 CLOSED IN POS.
12TM14
C28 8
C29 8
C30 3,3
C31 27
R29 200K
9TM11
C32 8
C33 8
C34 6
R31 920K
6TM8
C35 4,7 8
C36
R32 68K7
C37 6,8
C38 8
R33 992K
3TM5
C40 4,7 8
C39
R34 33K0C
C41 100
C42 8
R36 1M
1TM2
C45 4,7 8
C43
R37 796
C44 1K
+23 C
GL8 B26
C46 1K
R46 150K
R47 680K
0V
R52 33
R53 3K3
GR26 BAX17
+8,8V
R54 33
TS 26-1 BFW11
+1,3V
GR27 BAX17
+0,7V
R56 33
TS 28 BFY90
R57 100
R67 100
+8,2V
R50 3K9
R66 2K2
R59 3K9
R64 2K2
R44
-8,2V
C48 39
R76 44,2
R77 133
R78 237
2K37 R74
2K37 R79
100K C50
SK12 CLOSED IN POS.
FW5324
+0,7V
R60 12
R69 12
TS 32
R48 10M
R61 33
TS 29 BFY90
BAX17 GR28
+0,8V
+1,4V
TS 26-2 BFW11
C47 100K
R51 33
R49 2M2
R62 33
R63 100
+8,2V
-8,2V
R71 12
A
R72 226
-8V
R84 33
C48 10K
R73 200
-4,3V
TS 31 FW5324
+0,7V
R86 33
TS 33 FW5324
-5,4V
R87 1K
R101 12
R102 120
C53 10K
-0,8V
TS 36 BFY90
-6,1V
R103 240
B
+3,7V
C55 10K
BZY88C3V9 GR30
R97 22,1
R99 619
R98 332
R94 619
TS 38 BC107
-14,2V
-17,4V
R106 33
R108
R110 47
R109 100
-23 A
GAIN ADJ
R9 1K
R116 300
R8
R114 150
R115 500
R119 33
AMPL
TS 41 BC107
-0,6V
GR 35 BAX13
R123 3K
R122 180
0V
T 1402
-23 A
GR29 BZY88 C3V3
R107 8K2
+3,9V
R112 33
R111 33
TS 39 BFY90
R113 1K8
R117 33
R131 820
R118 33
+23 V
BZY88C18 GR 31
+8,1V
R704
R124 33
TS 42 BC107
-0,6V
R132 470
C60 22
R125 360
R126 2K2
-23 A
BZY88C8V2 GR32
R161 270
C58 100K
R162 27
C59 12,5µF
+23 V
GR33
R163 270
C61 100K
R164 27
C62 12,5µF
-23 V
GR 34
R166 680
C 63 100K
+3,9 V
DC BAL
R150
R152 4M7
+2,7V
R10 2K2
R153 2K4
R149 33K2
R148 10M
+2V
BC109C
TS43-1
TS43-2
R146 10M
+0,05V
R151 10M
R147 330K
R144 10M
C56 10K
R142 100K
R143 1K
C57 10K
R139 49,9
R138 49,9
R137 150
R136 249
R134 499
R133 1K5
SK12 CLOSED IN POS
R141 680K
MA 5981
25MC DUAL TRACE SCOPE
CH.A. ATTENUATOR
PRE AMPL.
PM 3210 / 02
HORSTEN
N.V. PHILIPS GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND
A2

BU5 R226 33 R227 100 SK11 CLOSED IN POS. 100K C226 C225 3,3 C227 27 R228 200K SK13 CLOSED IN POS. 12TM14 C228 C229 C230 3,3 C231 27 R229 200K 9TM11 C232 C233 C234 R231 920K 6TM8 C235 C236 R232 88K7 C237 C238 R233 992K 3TM5 C240 C239 R234 8K06 C241 C242 R236 1M 1TM2 C245 C243 R237 796 C244

+23C GL8 B201 C246 1K R246 150K R252 33 BAX17 R247 800K 0V

+23C R253 3K3 GR226 BAX17 +8,6V R254 33 BFW11 TS226-1 +1,3V GR227 +0,7V R256 33 R257 100 R258 3K9 R259 3K9 R267 100 +8,2V BFY90 TS228 0V R266 2K2 R264 2K2

-8,2V R248 10M C247 100K R251 33 TS226-2 BFW11 0V R249 2M2 R262 33 R263 100 +8,2V +8,2V

R268 12 -8,2V R271 12 A R272 220 -6V C248 10K R273 200 -4,3V TS231 FW5324 +0,7V R274 2K37 +23C 100K C250 R276 44,2 R277 133 R278 237 R279 2K37 R244 SK13 CLOSED IN POS. FW5324 +0,7V TS232 -4,4V C251 10K R281 200 R282 226 -6,1V R283 33 TS234 FW5324 -5,4V R288 1K R289 33 -8,2V R269 12 0V

-8,2V R271 12 R286 33 BZY88C3V9 GR230 +3,7V C255 10K B R303 240 R284 33 TS233 FW5324 -5,4V R287 1K R301 12 R302 120 C253 10K 0,8V TS236 BFY90 -6,1V R297 22,1 R299 619 R298 332 TS238 -14,2V BC107 R294 619 -17,4V R306 33 R307 8K2 GR229 BZY88C3V9 R293 12 BFY90 TS237 -0,7V R292 120 C254 10K R311 33 TS239 BFY90 +0,7V R291 237 R312 33 +3,9V 0V R313 1K8 R331 820 R332 470 R318 33 R317 33 R314 150 R12 1K AMPL R13 GAIN ADJ R316 300 R319 500 R310 47 R309 100 R308 BC107 TS241 -0,6V GR235 BAX13 R321 33 R320 5K6 R322 180 0V T402 R323 3K -23A

+8,2V BZY88C8V2 GR232 R361 270 C258 100K R362 27 C259 12,5µF +23V

-8,2V BZY88C8V2 GR233 R363 270 C261 100K -23A R364 27 C262 12,5µF -23V

+3,9V BZY88C3V9 GR234 R363 680 C263 100K +23V

+23V BZY88C19 GR231 +3,4V R324 33 R706 TS242 BC107 -0,6V R326 2K2 R325 360 C260 22 -23A

+2,7V R352 4M7 DC BAL R350 R11 2K2 R353 2K2 R349 33K2 R348 10M +2V BC109C TS243-2 R346 10M +0,05V R347 390K -0,4V R351 10M -8,2V 10K C257 0V BC109C TS243-1 C256 10K R342 100K R343 1K R344 10M R341 800K 0V SK13 CLOSED IN POS. R339 49,9 R338 49,9 R337 150 R336 249 R334 499 R333 1K5

MA 5982

25MC DUAL TRACE SCOPE
CH. B. ATTENUATOR PRE. AMPL.
PM 3210 / 02
HORSTEN
N.V. PHILIPS' GLOEILAMPENFABRIEKEN, EINDHOVEN - NEDERLAND
A

R 772
C 801 15
+0,6V
R 801 8K2
R 802 270
R 803 56
R 804 220
+21V
C 802 100K
R 806 82
TS 801 BFY 90
C 803 68
R 807 27
+ 23 A
C 804 10
+21V
TS 802 BSX 20
TS 803 BSX 20
R 808 390
R 809 1K5
R 810 1K5
R 811 180
C 806 150
R 812 1K5
R 813 10K
R 102 ?
-2,2V
-40V
- 23 A
R 814 270
R 816 12K2
+1,8V
R 817 270
TS 804 BSY 39
C 509
+ 85 A
R 821 220K
+ 6,2V
+ 0,1V
BC 109C
TS 806
R 818 470
C 807 3K3
TS 807 BC109C
R 822 10K
R 823 100
C 808 100K
+ 23 A
- 23 V
TIME/cm
R 4 22K
C 809 100K
R 824
SK 7
R 826 56
15K
TS 808 BC107
-0,5V
C 811 4,7
R 827 15K
R 832 18K
R 834 15K
+ 85 A
R 828 27K
R 831 33K
TS 809 BCY70
R 830 330
C 810 100K
R 836 56
+ 40,6V
+ 34,4V
+5,9V
-0,9V
BZY88C5V6
GR801
R 838 330
C 812 100K
R 833 10K
R 839 680
R 837 220
- 23 A
R 844 10K
R 841 390
TS 811 BC107
-2,5V
-8,8V
R 843 390K
R 842 12K
- 23 A
- 85 A
R 901 82K
BU 6
R 902
+3,5V
-2,7V
+ 23 A
R 854 27K
-5V
1K3 R 853
STAB.
R 6 470
R 856 18K
R 857 4K7
R 846 680
2,5µF C 813
BAX13 GR808
SK 5
GR 804 BAX13
R 847 33K
R 851 56
-20,9V
TS 812 BC 109
-21,5V
2,5µF C 814
R 849 2M7
GR 806 BAX13
GR 807 OF 162
-21V
-21,6V
R 848 22K
- 23 A
-3,2V
-5,2V
R 861 - R 871
C 823 - C 832
SK6IR
SK6IIR
SK6IIIF
SK6IIIR
R 861 300K
R 862 120K
R 863 60K4
R 864 33K2
R 866 1M2
R 867 600K
R 868 120K
R 869 60K4
R 871 3M
C 816 4K7
C 817 680
C 818 22K
C 819 220K
C 821 1M
C 822 220
C 823 22
C 824 150
C 825 33
C 826 65
C 827 910
C 828 10K
C 829 100K
C 830 17
C 831 1M
C 832 10M
R 872 8,2
25-SK10 + 23 V
R 873 68
C 833 12,5µF
C 834 100K
+ 23 A
- 23 V
R 874 68
C 836 12,5µF
C 837 100K
- 23 A
+ 85 V
R 876 330
C 838 100K
+ 85 A
- 85 V
R 877 330
C 839 100K
- 85 A
MA5983
25MC DUAL TRACE SCOPE
TIME BASE CIRCUIT
PM3210|02
HORSTEN
N.V. PHILIPS' GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND
A2

T.B. UNIT
R 837

R902 33 -2,6V TS901 BC107
R914 3K9 +12,4V
+18,7V
R903 270K
R916 12K -3,3V -23A
R904 931
R906 18K
R907 9K1
R908 18K
R917 6K49
R918 12K -3,3V -23A
GR901 BAX13
GR902 BAX13
SK8
+23 V
-23 V

R909 33 -2,7V TS902 BC107
R919 3K9 +12,4V
+18,7V
R911 22K
R7 47K POSITION MAGN.
R913 3K9
C901 100K
+23A
-23A

R921 6K8
R923 6K8
GR906 BAX13
GR907 BAX13
GR909 BAX13
C902 100K
3- SK10
R922 100K 0V
-23A

R447 R446
+22,3V +22,3V
BAX13 BAX13
GR911 GR912
C903 1
R924 4K42
R926 33
+19,4V
TS903 FW5324
R927 240
R928 240
R929 33
R931 4K42
C904 1
TS904 FW5324
R934 22
R937 22
R936 300 +23A +20,1V
+23A
R932 7K5
R933 33 +2,4V
TS906 FW5324
R941 33
-23A
R938 33
TS909 FW5324
+2,7V
R939 7K5
R951 33
-23A

+23A
R942 39K
R943 33 -27V
TS907 FW5324
GR913 BAX13
+4,2V
R944 10K
C906 22
R946 1K
R947 6K8
R952 2K7
R953 2K7
R954 33
TS911 BCY70
+10,6V
R956 1K5
C907 100K
R957 12K
R958 5K1
4K7 R959
+23A
GR914 BAX13
FW5324
TS908
R948 33
-27V
R949 39K
+23A
GR916 BZX61C47
GR917 BZX61C47

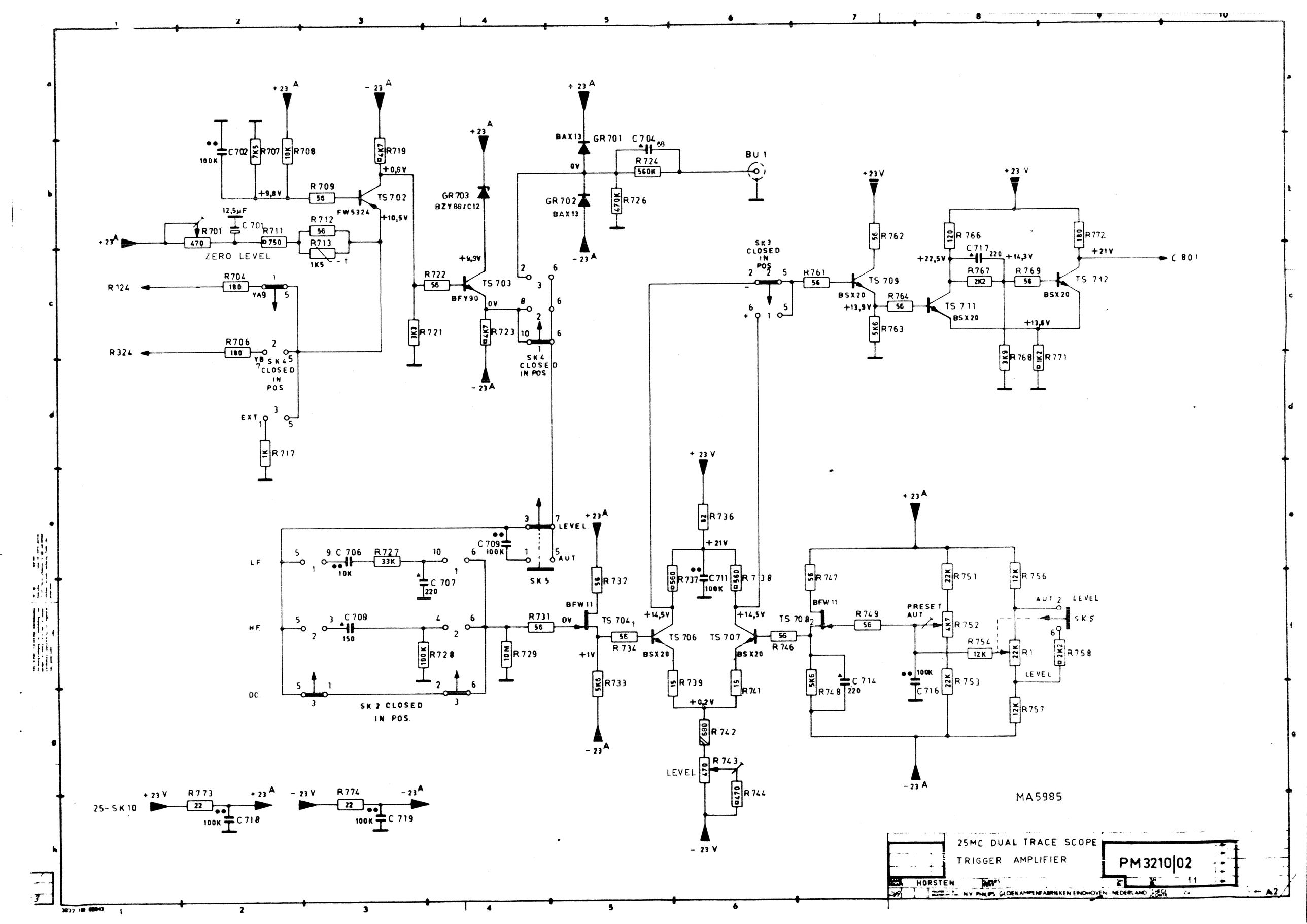
+85A
R968 27K
+62,6V
R969 62K
R978 33
BFW44 TS914
R983 2K
R991 18K
0V
X1 B1001-6
-85A
C908 1
R961 27K
R971 33
C911 100K
C913 100K
-76,2V
R962 33
TS912 FW5324
R979 33
TS916 BF179
R963 1K5
R972 12K
-85A
R985 470
-76,1V
-85A
R964 1K5
R973 12K
R981 33
BF179 TS917
R966 33
TS913 FW5324
-76,2V
C909 1
R967 27K
R974 33
C912 100K
C914 100K
-85A
0V
X2 B1001-4
R976 62K
+61,6V
R982 33
BFW44 TS918
R980 18K
R977 27K
R984 2K
+85A
+85A

R986 22 +23V +23A
C916 100K
R988 22 +85V +85A
C918 100K
R987 22 -23V -23A
C917 100K
R989 22 -85V -85A
C919 100K

MA5984

25MC DUAL TRACE SCOPE
X-FINAL AMPLIFIER
PM 3210/02
10
HORSTEN
N.V. PHILIPS GLOEILAMPENFABRIEKEN, EINDHOVEN, NEDERLAND
A2

3822 100 08864


+23 A
-23 A
C702 100K
R707 7K5
R708 10K
R719 4K7
+0,8V
+9,8V
R709 56
TS702 FW5324
+10,5V
12,5µF
C701
R701 470
ZERO LEVEL
R711 750
R712 56
R713 1K5
-T
+23A
R124
R704 180
YA9
R324
R706 180
YB
SK4 CLOSED IN POS
EXT
R717 1K
GR703 BZY88/C12
+4,9V
R722 56
TS703 BFY90
0V
R721 3K3
R723 4K7
SK4 CLOSED IN POS
GR701 BAX13
C704 68
R724 560K
BU1
GR702 BAX13
R726 470K
SK3 CLOSED IN POS
R761 56
+23V
R762 56
TS709 BSX20
+13,9V
R764 56
R763 5K6
R766 120
C717 220
+22,5V
+14,3V
R767 2K2
R769 56
TS711 BSX20
TS712 BSX20
R772 180
+21V
C801
+13,6V
R768 3K9
R771 1K2
LF
HF
DC
C706 10K
R727 33K
C707 220
C709 100K
SK5
LEVEL
AUT
SK2 CLOSED IN POS
C708 150
R728 100K
R729 10M
R731 56
R732 56
BFW11
TS704
R734 56
+1V
R733 5K6
R736 82
+21V
R737 560
C711 100K
R738 560
TS706 BSX20
TS707 BSX20
+14,5V
R739 15
R741 15
+0,2V
R742 680
R743 470
R744 470
R747 56
R749 56
TS708
R746 56
R748 5K6
C714 220
C716 100K
PRESET AUT
R751 22K
R752 4K7
R753 22K
R754 12K
R756 12K
R1 22K
R758 2K2
R757 12K
AUT 2
LEVEL
SK5
25-SK10
R773 22
C718 100K
R774 22
C719 100K
MA5985
25MC DUAL TRACE SCOPE
TRIGGER AMPLIFIER
PM3210|02
HORSTEN
N.V. PHILIPS GLOEILAMPENFABRIEKEN EINDHOVEN NEDERLAND
A2